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Title: ACOUSTIC STEADY-STATE EXCITATION SPATIAL SPECTROSCOPY (ASSESS)

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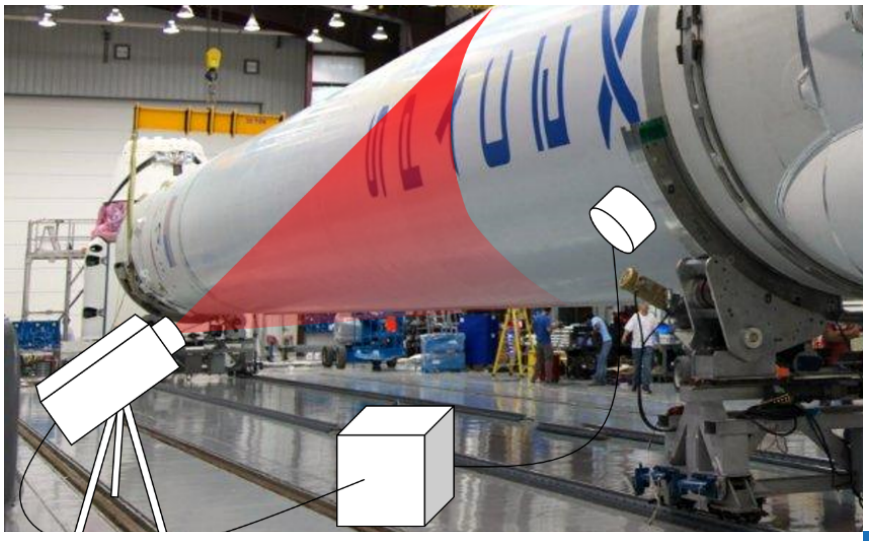

Los Alamos NATIONAL LABORATORY EST.1943

Tech Snapshot

Sensors

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ACOUSTIC STEADY-STATE EXCITATION SPATIAL SPECTROSCOPY (ASSESS)

Rapid Full-Structure Non-Destructive Evaluation Tool for the Aerospace Industry

SUMMARY

Safely launching and landing spacecraft, especially reusable spacecraft, requires detailed inspections of the launch vehicle to identify potential manufacturing and service-induced flaws. As an automated full-structure ultrasonic scanning technology, Acoustic Steady-State Excitation Spatial Spectroscopy (ASSESS) can rapidly and non-intrusively detect a wide variety of defects in applications where identifying subtle flaws is paramount. ASSESS is a non-destructive evaluation technology that leverages continuous excitation and laser Doppler vibrometry to make fast, high-quality inspections at stand-off distances. The ASSESS technology has undergone extensive laboratory testing and several field tests specific to oil and gas and additive manufacturing applications. We seek a commercialization partner to fund aerospace application-specific R&D and product development through a Cooperative Research and Development Agreement (CRADA).

MARKET APPLICATION

While traditional ultrasonic testing is done by manually probing discrete points on a structure, ASSESS provides a full-field analysis capability that could reveal flaws that might be missed with point-based inspection methods. ASSESS would enable complex full-structure inspections on tight schedules common in the aerospace industry. In-process aerospace manufacturing inspection, reusable launch vehicle inspection, payload pre-integration inspection, and aircraft inspection all could benefit from this capability. ASSESS has the ability to provide increased confidence in the integrity and safety of launch vehicles, payloads, and aircraft by detecting hidden flaws before they cause catastrophic failures. Right now, ASSESS could be offered as a service and, with further development, as an integrated hardware/software solution.

BENEFITS

ASSESS provides an integrated, portable, full-structure rapid inspection solution that can scan anything from a detailed additive manufactured part to an entire reusable spacecraft.

- Several orders of magnitude faster than comparable laser ultrasonic NDE techniques, enabling large area, full-structure scans of systems
- Capable of inspecting, analyzing, and visualizing results from full 3D structures
- Portable and deployable to various inspection applications with a single integrated hardware and software system
- Higher signal-to-noise ratio than other laser ultrasonic NDE techniques with same measurement time
- Flexible excitation source placement
- Uses only eye-safe lasers ensuring the safety of personnel in inspection area

CONTACT

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WHY WE ARE BUILDING ACOUSTIC STEADY-STATE EXCITATION SPATIAL SPECTROSCOPY (ASSESS)

ASSESS was born as a structural health monitoring tool developed in the Engineering Institute at Los Alamos National Laboratory. Working with an industry partner, Los Alamos engineers began developing tools to support inspection needs in the oil & gas sector. This technology has been applied to inspect additive manufactured parts as they are built. Considering the specific demands of aerospace structural inspections (e.g. large inspection area, high-resolution requirements, tight timeframes), the capabilities that ASSESS brings to the non-destructive evaluation market may be a fitting match for many applications in the aerospace industry.

WHAT'S BEHIND OUR TECHNOLOGY

ASSESS produces rapid scans of real-world structures by continuously exciting them with a narrowband ultrasonic signal and measuring the surface response of the structure with a scanning laser Doppler vibrometer. This produces a full-field surface velocity measurement of the structure that contains rich information about how the ultrasonic waves interact with the structure and potential defects. Depending upon the defect type of concern, the velocity measurement can be fed into different defect detection algorithms to produce full-field damage assessments. A key component of the ASSESS technology is a proprietary damage detection algorithm based on local wavenumber analysis which can reveal hidden corrosion and de-lamination in thin structures. Local wavenumber estimates can also be further processed into local thickness estimates. We are also developing techniques to detect flaws in coatings and additive manufactured parts.

OUR COMPETITIVE ADVANTAGES

This capability is an ideal solution for applications where identifying subtle flaws is paramount but competing methods would be impossibly slow and labor-intensive. ASSESS overcomes many of the practical limitations that keep competing non-destructive evaluation systems in the laboratory and out of the field. With a robust sensing technique, faster scan times, the capability to register ultrasonic response measurements to 3D structure geometry automatically, and safer equipment, the ASSESS technology has fundamental advantages that are difficult for competing solutions to surpass without significant R&D investment. ASSESS is adaptable to a vast array of inspection problems and the set of potential application spaces for ASSESS is expected to keep growing.

OUR TECHNOLOGY STATUS

This technology has been extensively validated in the laboratory with several prototype systems. Los Alamos engineers have also conducted a few field tests in industrial settings. To date, the development of the ASSESS technology has focused on inspecting thin-walled, metal and composite structures for hidden corrosion and de-lamination and in-process quality control for additive manufacturing, but other inspection applications could also be evaluated, such as joint and fastener failure and coating integrity. The next steps involve transitioning these prototypes to more robust implementations, advancing our analysis and visualization methods for existing applications, and continuing to adapt the technology to new application spaces. We are seeking application development partners interested in supporting R&D for aerospace applications through a CRADA partnership as well as potential commercialization partners to bring our technology to market.

PUBLICATIONS AND IP

Patents:

NONDESTRUCTIVE INSPECTION USING CONTINUOUS ULTRASONIC WAVE GENERATION; U.S. Pat. No. 10,444,202

SYSTEM AND METHOD FOR IN-PROCESS INSPECTION WITHIN ADVANCED MANUFACTURING PROCESSES; U.S. Pat. No. 10,794,836

Related Publications:

E.B. Flynn, G.S. Jarmer, “High-Speed, Non-Contact, Baseline-Free Imaging of Hidden Defects Using Scanning Laser Measurements of Steady-State Ultrasonic Vibration,” 2013

Eric B. Flynn, Nicholas D. Stull, “Toward Utilizing Full-Field Laser-Ultrasound for Practical Nondestructive Inspection with Acoustic Wavenumber Spectroscopy,” 2018

Peter H. Fickenwirth, Matthew J. Adams, Eric B. Flynn, “Three-Dimensional Acoustic Wavenumber Spectroscopy for Structural Health Monitoring,” 2019

Joshua D. Eckels, Isabel F. Fernandez, Kelly Ho, Nikolaos Dervilis, Erica M. Jacobson, and Adam J. Wachtor, “Application of a U-Net Convolutional Neural Network to Ultrasonic Wavefield Measurements for Defect Characterization,” 2021

Casey Gardner, Young Ko, Michael Koutoumbas, Eric Flynn, Ian Cummings, Phil Cornwell, “Delamination Detection in Fiber Metal Laminates using Ultrasonic Wavefield Imaging,” 2021